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# MICROWAVE RADIATION CHARACTERISTICS OF DRY AND MOIST GROUND COVERS

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16. Abstract

Microwave measurements from space can be used to detect fires, measure soil moisture and temperature, measure sub-ice soil temperatures and the thickness of ice cover, as well as in the search for subsurface water.

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# MICROWAVE RADIATION CHARACTERISTICS OF DRY AND MOIST GROUND COVERS

A.E. Basharinov, L.F. Borodin, S.T. Egorov, A.M. Shutko

(Communication to the Seminar of the Soviet-American Working Group on Land Resource Survey by Remote Sensing Methods)

1. Measurements of the microwave radiation from ground covers are potentially capable of yielding solutions to a number of problems in defining the temperature and state of ground covers under difficult weather conditions. Thus, microwave radiometry allows us to determine the ground temperature underneath snow or ice cover, to fix the moisture content of the surface layer, to carry out a search for ground water, to detect areas of burning peat-bogs and forest fires, to determine the thickness of ice and snow covers, and the like.

2. The data needed to solve any of these problems is contained in the contrast-, spectral- and polarization- characteristics of the earth's microwave radiation in the centimeter and decimeter bands.

Thus, with known temperatures along the track of the field of view of the radiometer, contrast measurements permit estimation of the space-time variations in permittivity and, with measurements above uniform covers( deserts, forests), of the temperature field variations as well.

The spectral measurements make it possible to estimate the deep vertical permittivity profile or the temperature and the nature of the soil.

Polarization measurements permit estimating the permittivity of the surface layer, with known temperatures of the underlying surface.

3. Observations made above dry, uniform covers devoid of dense vegetation permit measurement of the mean-monthly ground temperatures from radio-brightness measurements in a single centimeter-wave channel. Thus, the latitudinal changes in temperatures of the surfaces of Australia and North Africa were established from measurements made by radiometers aboard the satellite "Cosmos-243", in 1968, and "Cosmos-384" in 1970. The findings were in agreement with the mean-monthly air temperatures in these regions.

Fig. 1 shows the brightness temperature profile obtained in a flight over Australia [1].

The latitude trend of the temperature is less well-expressed for the Sahara; this is completely in accord with the known picture of the temperature regime in this region. Spectral contrast measurements show that the diurnal thermal trend has a marked effect on the brightness temperature as measured in the short-wave region of the centimeter band.

4. Pronounced contrast characteristics are to be expected in the presence of fires. Observations of radio-brightness contrast in areas of burning peat-bogs and forest fires yielded abrupt increases of $100^o$-$300^o$ above the background temperature. Fig. 2 shows examples of the brightness contrast found in burning sectors of peat-bogs, obtained from aircraft observations at a wavelength of about 8 mm. In areas with a transverse dimension of 30-50 meters the brightness temperature spikes amounted to $100^o$-$200^o$ K.

5. Measurements of the radio brightness characteristics of moist surfaces in the Soviet Union (cm-band) and in the United States (cm- and dm-bands) have shown that the brightness temperature and the moisture content

of the soil are correlated.

Fig. 3 illustrates the dependence of emissivity and polarization coefficient on the moisture content of the soil, as obtained by computation [3].

Measurements above salt-marshes showed considerable variation in brightness -- by as much as tens of degrees Kelvin -- in the absence of patches of open water on the surface. Estimates show that such variations in brightness correspond to fluctuations in moisture content of 7-10%. The accuracy of the ground moisture estimate made from microwave radiometer data was 3-5% for surfaces lacking vegetation cover. The influence of vegetation was significant in the centimeter range and was at times evident in the decimeter range.

6. Microwave observations of the radiation from glaciers and permafrost pointed to the possibility of making estimates of the moisture content of snow and of the glacier temperature. Thus, for example, satellite measurements made over Antarctica during 1968 and 1970 revealed a correlation between the mean-monthly glacier temperatures and the radiometric temperature estimates [1,2]. The glacier temperature estimates from data of microwave and infrared measurements, shown in Fig. 4, are in good agreement.

Due to the weak absorption of microwaves in snow cover, the brightness temperature observations can be used to estimate the ground temperature.

7. The accumulated data on the microwave radiation characteristics of ground covers allow making some recommendations regarding the choice of

spectral regions and measuring methods. To check the temperature and state of the ground cover, the cm-range appears suitable in the absence of a vegetation cover. With vegetation cover, or in measurements on snow-covered ground, the 10-30 cm wavelength range can be recommended.

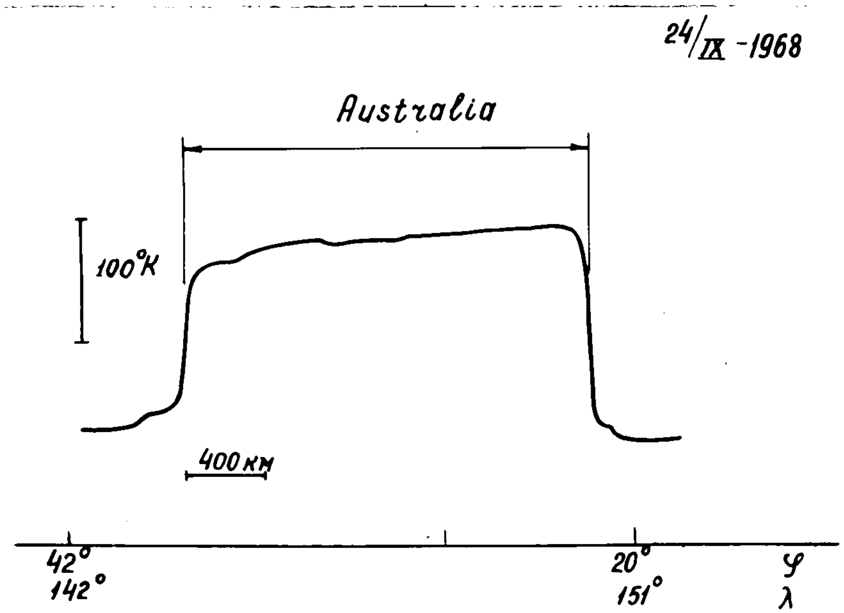


Fig. 1. Change in radio brightness-temperature over Australia.

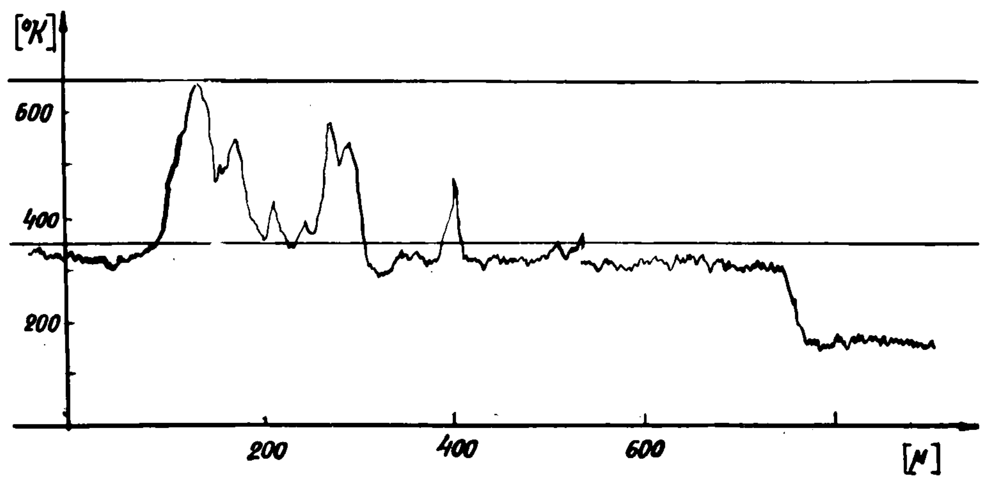


Fig. 2. Example of the variation in radio brightness in areas of burning peat-bogs.

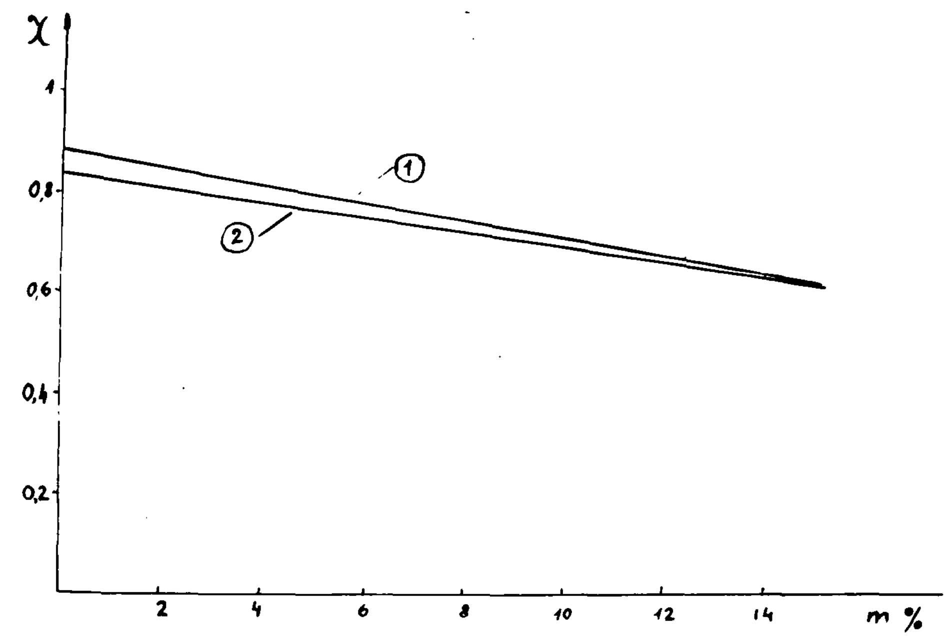


Fig. 3. Dependence of ground emissivity on moisture content

① sand ② clay

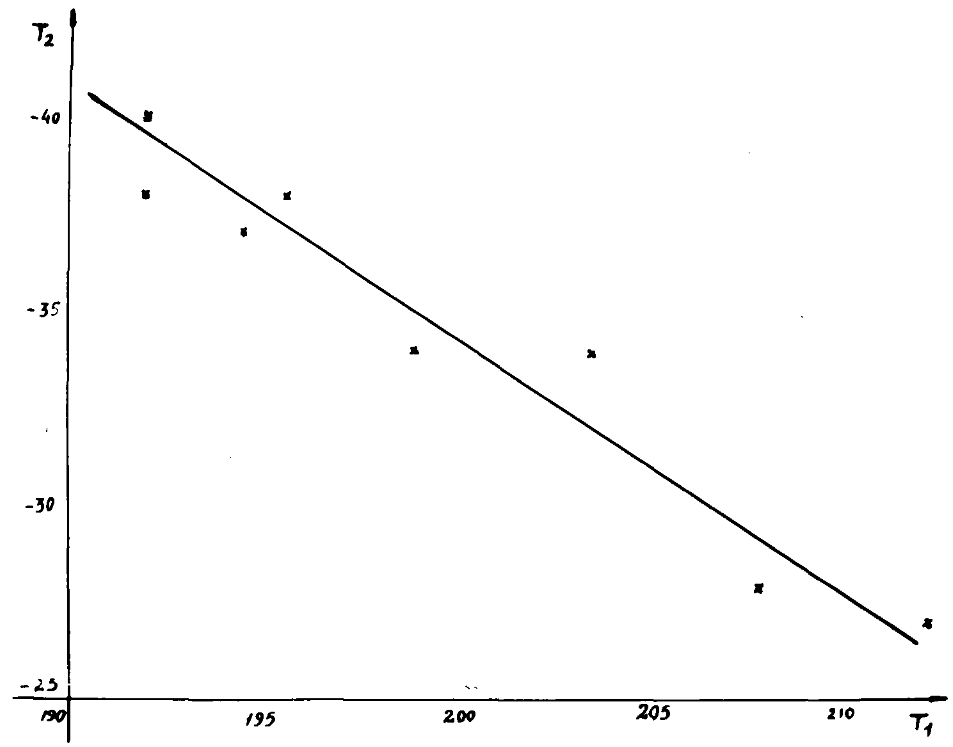


Fig. 4. Correlation between radio brightness and infrared radiation temperature of Antarctic glaciers.

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